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Celebrating Evelyn Fox Keller: “The Toronto Statement”

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With much anticipation, in time and spirit, a group of historians and philosophers of biology, and theoretical and experimental biologists, met at the Institute for the History and Philosophy of Science and Technology at the University of Toronto, Canada, on 22 and 23 September 2023, to pay homage to Evelyn Fox Keller for her contributions to theoretical biology. The conference was supported and sponsored by the Department of Philosophy, Institute for the History and Philosophy of Science and Technology, Faculty of Arts and Science (all at University of Toronto), as well as the Social Sciences and Humanities Research Council of Canada. The workshop was an in-person celebration complementing the publication of a volume celebrating her work (Vicedo & Walsh 2020a, 2020b), which includes the following contributions: (Herrington & Jablonka 2020; Longo & Mossio 2020; Radick 2020; Riskin 2020; Soto & Sonnenschein 2020; Walsh 2020). After introductory remarks by co-organizer Denis Walsh and a short video

in which Evelyn Fox Keller thanked us for this homage and wished us well, we learned of her death.



Figure 1. *Evelyn Fox Keller: Making sense of gender and science* (ink and pencil) by Anna (Anat) Zeligowski

Perhaps the overarching message that emerged from the two-day conference “Language, History, Gender, and Science: Celebrating the Work of Evelyn Fox Keller” is that historians, philosophers, sociologists of science and biologists are nowhere near done thinking through the vexing and complex roles of gender, metaphor, reductionism, and mechanism in the life sciences. Conference attendees joined in thanking Keller for doing so much to uncover and critique these challenging—but perhaps also generative—features of the life sciences. And in a closing session, participants reflected on the seemingly unshakeable dominance of genetic determinism in biological theory and practice as co-organizer Marga Vicedo forcefully asked, “But how do we change things?” Thought without action is empty, and in this brief conceptual review of the conference, we summarize some key themes, diagnose outstanding challenges, and report some calls to action brought up by conference attendees.

All literatures are saturated. Even so, we believe that Keller’s work is sufficiently important and trenchant to make a public record of this conference worthwhile. In this necessarily brief report, our organizing principle will be to group key themes of different talks in terms of four of Evelyn Fox Keller’s books. This is solely a strategy of convenience—there is no intent of denigrating or ignoring her other work. We conclude with some comments on art and science, a topic Keller did not explicitly address.

1. The Mirage of a Space between Nature and Nurture (2010). Durham: Duke University Press

Why do the life sciences—particularly those concerned with development, heredity, and evolution—continue to ground analyses on a strong/stronger nature (genes, DNA) versus nurture (environment, culture) distinction? Yes, we are all aware that these elements interact, and yet...

History matters. Eva Jablonka has long argued that not only is there change in heritable patterns of gene expression, but there are also important effects of epigenetic states of the rate and types of mutations in DNA (Jablonka & Lamb 1995, 2006, 2020; Monroe *et al.* 2022). Giuseppe Longo distinguished dynamic state spaces in biology versus pre-given “transcendental” state spaces in physical theories. In so doing, he detailed

different forms of mechanisms in physics and hinted at a close analysis of “physical emergence” versus “production of biological novelty”, in order to illuminate biological historicity (Longo & Montévil 2014, Longo 2021; Riskin 2016).

Constant interaction. Gregory Radick presented a triangle, modelled on the fire triangle, with sides labelled “oxygen”, “fuel” and “heat”. The phenotype triangle that Radick introduced in his talk had sides labelled “genotype”, “internal context” and “external context”, to give visual expression to the Weldonian-Lewontian-Kellerian perspective in which talk of genotypes causing phenotypes feels as absurd as talk of oxygen causing fires (Radick 2020, 2023).

Plant plasticity. Sonia Sultan’s phenotypic plasticity discussion moved norms of reaction from “properties of the genome” (standard view) to dynamic, complex, often adaptive and sometimes multi-generational behaviors of plants which take place without coordination by a brain or consciousness (Sultan 2019, 2021).

Not only a question of semantics: nature/nurture in Daniel Lehrman’s work on animal behavior. Reviewing developmental psychologist Daniel Lehrman’s contributions to animal behavior, Marga Vicedo talked about his pioneering work that highlighted the active role of organisms in constructing their environment. She also noted how Lehrman made significant contributions by clarifying key concepts in the nature versus nurture debate (Vicedo 2023a; Vicedo 2023b). However, Vicedo argued that semantic analysis (“linguistic hygiene”) will never be sufficient to resolve/dissolve the nature versus nurture debate. She suggested



Figure 2. *Five mothers: Inputs to development and heredity* (ink and pencil) by Anna (Anat) Zeligowski

moving beyond reductionist research that is premised on and further entrenches that debate and its (misguided) underlying assumptions. In her view, we need a new type of science that allows for detailed analysis of the complex factors that dynamically interact in biological systems.

2. Refiguring Life: Metaphors of Twentieth-Century Biology (1995). New York: Columbia University Press

“*Refiguring Life* begins with the history of genetics and embryology, showing how discipline-based metaphors have directed scientists’ search for evidence. Keller continues with an exploration of the border traffic between biology and physics, focusing on the question of life and the law of increasing entropy. In a final section she traces the impact of new metaphors, born of the computer revolution, on the course of biological research” (From the original book description).

Towards a theory of organisms. Ana M. Soto and Carlos Sonnenschein argued that metaphors may inspire new concepts but play a different role than theories (Soto & Sonnenschein 2020). Scientific theories are needed to determine observables, frame experiments, and provide understanding (Longo & Soto 2016; Winther 2020b). A “theory of organisms” encompassing the entire life cycle would help clarify the difference between organisms, which are historical purposive agents and non-historical inert objects (Soto *et al.* 2016). Three principles for such a theory were enunciated: constitutive proliferation and motility (Soto, Longo, Montévil, & Sonnenschein 2016), constitutive variation (Montévil *et al.* 2016) and organization by closure of constraints (Mossio *et al.* 2016; Walsh 2015). These principles were also used to frame a theory of cancer, the tissue organization field theory (TOFT) (Sonnenschein & Soto 2020).

Metaphorical reductions. “Lamarckian inheritance of acquired traits”, “the Weismannian barrier”, and “the Mendelian Gene”. Key theoretical biological advances often involve a *hardening* (S. J. Gould) and a kind of *nothing-but* (William James) thinking, where the rich complexity of the key theoretician’s framework is productively yet perniciously reified (Winther 2020a). But is Weismannism to Weismann as Mendelism is to Mendel, as Darwinism is to Darwin, as Lamarck is to Lamarckism (Riskin 2023; White, Hodge, & Radick 2021; Winther 2000,

2001; Radick 2023)? Should we be mindful of such metaphorical reifications of the views of single biologists, and of the cross-biologist (dis)analogies? For instance, the Weismannian barrier, which Weismann himself did not necessarily endorse, has been a scientific dogma that originated in a religious dogma, and has stood as a barrier partitioning evolutionary development from the agency of organisms.

3. Secrets of Life/Secrets of Death: Essays on Language, Gender and Science (1992). New York: Routledge

“Part of the motivation for this book is to distinguish the particular strand of ‘Gender and Science’ studies concerned with the role of gender ideologies *in* science, and to embed it in a more general historiographic and philosophical pursuit” (Keller 1992, p. 8).

Sex contextualism. In earlier work, Sarah Richardson

“examine[d] the interaction between cultural gender norms and genetic theories of sex from the beginning of the twentieth century to the present, postgenomic age ... using methods from history, philosophy, and gender studies of science” (Richardson 2013, book description).

In her conference talk, Richardson used a philosophical approach to statistics to present multiple *reductiones ad absurdum* of the assumption of intrinsic sex. She indicated how “sex contextualism” was itself a fruitful and important research program (Richardson 2022).

A dialectical feminism? Rasmus Winther argued that a dialectical feminism highlights the promise of approaching contradictions generatively—reason meets intuition, objectivity meets subjectivity, reduction meets pattern, and linear causation meets complex causation (Winther 2021). It is a critical and capacious stance that can produce good normal and revolutionary science, and can also call for an ethical approach to science.

Circuses and octopi. Zeligowski’s circus drawings in the onsite Zeligowski IHPST exhibit resonate with Lynn Margulis’ octopoid woman incessantly multitasking:

“A woman must be almost octopoid in her attentions if she is to survive. Holding the infant in one arm, [Mary

Catherine] Bateson points out, she stirs the pot with the other, while she watches the toddler” (Margulis 1998, p. 24).

4. A Feeling for the Organism: The Life and Work of Barbara McClintock (1983). New York: W.H. Freeman

Keller’s classic biography of Barbara McClintock shed light on McClintock’s holism, and her focus on chromosomal organization and what McClintock called the “reactive genome”.

Towards a philosophy of nature. Philosophy of nature is an integrative, holistic, and inclusive philosophy—it remains open to teleology, emotions, even mysticism, in the interest of giving a more accurate and meaningful portrayal of our world (Winther 2019). It stands in a creative, dialectical contrast to analytic philosophy of science. Following Keller, one could call McClintock a philosopher of nature. In the last chapter of her biography, Keller had spoken of McClintock’s “deep reverence for nature [and] a capacity for union with that which is to be known” and cites her in describing McClintock’s own “love affair with the world”, which included the facts that McClintock gladly called herself a “mystic” and believed that “everything is one” (Keller 1983, pp. 201, 204–205).

A feminine way of doing science? Sonia Sultan, Jessica Riskin, and Sarah Richardson provided different exegetical standpoints from second wave and third wave feminisms in the discussion following Winther’s talk. Are empathic or holistic approaches necessarily gendered? Keller’s version of feminism was universalist, not identity feminism. As she put it in a 1986 interview with Boston Globe cited in her *The New York Times* obituary, “I am not saying that women will do a different kind of science, I am saying when there are more women in science, everybody will be free to do a different kind of science” (Risen 2023). Moreover, in her 2023 memoirs, *Making Sense of My Life in Science*, she responded to the so-called McClintock Myth (Comfort 2003) by citing a long passage from her 1985 book *Reflections on Gender and Science* (pp. 174–175), which included these sentences:

“Her ... [i.e.,] any scientist who happens to be a woman ... alternative is to attempt a radical redefinition of terms. Nature must be renamed as not female, or, at

least, as not an alienated object. By the same token, the mind, if the female scientist is to have one, must be renamed as not necessarily male, as gender neutral, and accordingly recast with a more inclusive subjectivity ...”

As a final comment, participants considered a topic resonating with, e.g., Keller’s work on generative metaphor in science: the productive interface between art and science (Herrington & Jablonka 2020). Jablonka’s beautiful talk, and the resonances with the IHPST art installation of Anat Zeligowski highlighted this connection (Ginsburg & Jablonka 2022). What is the role of aesthetic judgment (*à la* Kant, Romanticism, and *Naturphilosophie*) in the context of discovery and in the context of justification of science (Winther & Raffn 2024)? How can art and aesthetic judgment help us think about the theory-data or representation-phenomena relations? How does Waddington’s analysis on the resonance between art and science in the 20th century (Waddington 1969) illuminate these questions?

In sum, there is much work to do to move beyond the reductionist and metaphorical “gene thinking” that Evelyn Fox Keller so cogently and eloquently worked to dismantle. Her contributions to gender and science discourse also continue to be influential and of going concern.

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